FOREST PRODUCTS
Project Fact Sheet

WATER RECYCLING/REMOVAL USING TEMPERATURE-SENSITIVE HYDROGELS

BENEFITS

- Simplification of water-removal process
- A 20-fold reduction in energy consumption compared to triple-effect evaporator
- Potential for zero energy costs for the new process
- Lower capital costs than conventional process (evaporation)
- Reduction in operational costs of pulp and paper mills
- Potential to significantly increase mill's evaporator capacity

APPLICATIONS

Adoption of the hydrogel water-removal technology will result in significant energy and environmental benefits to mills. In particular, it will make it possible for them to increase their evaporation capacity and to comply with the requirements of the Cluster Rule.

New Technology Has the Potential To Save Large Amounts of Energy in the Kraft Recovery Cycle

The pulp and paper industry uses large amounts of water in its processes, and will be under increased pressure to recycle this water. Increasing costs and compliance with the Environmental Protection Agency's recent Cluster Rule require the industry to reduce the load on waste treatment plants. An energy-efficient method of water removal is available using temperature-sensitive hydrogels, which absorb large amounts of water at low temperatures without dissolving, and are re-activated to release clean water when the temperature is raised. In the process, contaminants such as black liquor spills and oxygen delignification filtrates are concentrated in the exit stream. For each 1 percent of black liquor removed, there is an 8 percent increase in evaporator capacity, an important consideration in mills with limited numbers of evaporators.

Preliminary tests with water have shown promising results, with 6 kg of water removed per kg of hydrogel. Indications are the hydrogel could be reused more than 1,000 times without loss of potency. It is projected that 20 times less energy will be required for water removal when this process is compared with the triple-effect evaporator. Other advantages to the technology are lower capital costs, a simpler water-removal process, and the potential for essentially no energy costs if a waste-heat source is available to heat the hydrogel to the water-release temperature. The hydrogel process is anticipated to be a major advance in water removal in the pulp and paper industry.

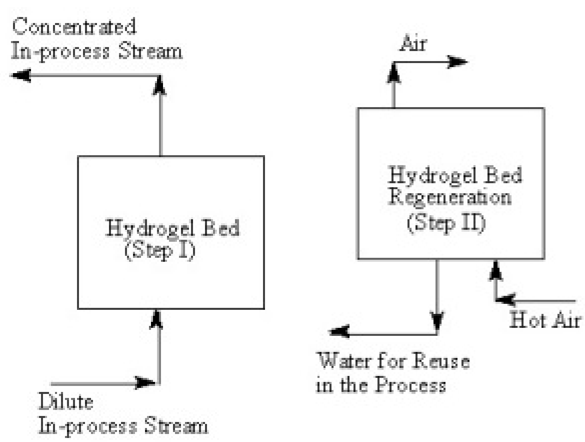


Figure 1. Diagram of the proposed process for recycling/removing water used in pulp and paper manufacturing.

PROJECT DESCRIPTION

Goal: To develop a new energy-efficient water recycling/removal process for the pulp and paper industry.

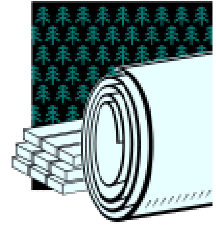
Auburn University researchers will study at least six different polymer-based hydrogels to determine if they can be used in the pulp and paper industry. For example, Auburn's poly (N-isopropylacrylamide) (PNIPA) hydrogel absorbs a large quantity of water at 25^{o}C but releases the water if the temperature is raised to 35^{o}C. Larger molecules and solid particles are rejected by the small pores of the hydrogel and become concentrated in the exit stream. Since temperatures of in-process water streams and spent-pulping liquor in pulping mills are typically 50^{o}C–60^{o}C, and at a pH of 4–11, the promising hydrogels must be redesigned for use in these temperature and pH ranges.

The research will focus on three pulp and paper processes: (1) **White-water clarification**, during which a hydrogel will be used to remove organic and inorganic dissolved and colloidal materials present after deinking mixed paper; the purified water remaining can be reused in mill processes; (2) **oxygen-delignification filtrate concentration**, in which low levels of lignin and alkali that are present after the first stage of pulp bleaching are separated for different purposes, with the lignin-rich portion sent to the evaporator and the alkali-rich portion used in brown stock washing; their separation with a hydrogel will improve the performance and energy efficiency of using this filtrate; and (3) **black-liquor spill concentration**, to collect black-liquor spills from various sources in the mill, and to use a hydrogel to concentrate the lignin and organic materials they contain before they go to the evaporators.

PROGRESS & MILESTONES

The schedule of tasks for the three-year project follows:

- April–December 1998: Auburn researchers synthesized and characterized a number of hydrogels
- January–May 1999: The performance of the hydrogels was studied under the potential conditions to be encountered in removing water from spent-pulping liquor (e.g., various temperatures, pressures, salt compositions, pHs, etc.).
- June–December 1999: Optimization of the molecular structure of the hydrogels is underway, based on their performance data; the best water sorption and hydrogel re-activation conditions will be chosen.
- January–December 2000: The hydrogel-based, water-removal unit will be designed based on environmental and cost considerations.
- January–March 2001: The water-removal operation will be adjusted, and a final report prepared on the technology.



PROJECT PARTNERS

Auburn University
Auburn, AL

Bowater Newsprint
Calhoun, TN

Dow Chemical Company
Midland, MI

FOR ADDITIONAL INFORMATION PLEASE CONTACT:

Merrill Smith
Office of Industrial Technologies
Phone: (202) 586-3646
Fax: (202) 586-1658
e-mail: merrill.smith@ee.doe.gov

Dr. Ram B. Gupta
Chemical Engineering Department
Auburn University, AL 36849-5127
Phone: (334) 844-2013
Fax: (844) 844-2063
e-mail: gupta@eng.auburn.edu

Please send any comments, questions, or suggestions to webmaster.eren@nrel.gov

Office of Industrial Technologies
Energy Efficiency and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

October 1998